

REMARKS

By the present amendment, claims 1-4 and 6 to 11 are pending in the application.

Support For Claim Amendments

Claim 1

Claim 1 has been amended to specify that in the method of the present invention --no plating solutions are used--.

This is supported in the specification, e.g., at page 8, lines 13-16.

Claim 2

Claim 2 has been amended to add the limitation --with said surface of said arrangement base plate facing downward during said provisionally arranging and holding procedure--.

This is supported, e.g., in Fig. 2(a) and the specification at page 5, lines 6-20.

Claim 3

Claim 3 has been amended to change "substrate" to --arrangement base plate-- in order to improve clarity.

§102/§103

In the Office Action mailed December 3, 2003, the following rejections were made.

Claims 1-3, 7, 8, 10 and 11 were rejected under 35 U.S.C. §102(e) as being anticipated by U.S. Patent No. 5,762,258 to Le Coz.

Claims 4, 6 and 9 were rejected under 35 U.S.C. §103(a) as being unpatentable over U.S. Patent No. 5,762,258

to Le Coz in view of U.S. Patent No. 4,980,240 to Dunaway et al.

These rejections, as applied to the amended claims, are respectfully traversed.

Patentability

The present invention defined by the amended claims is not disclosed or suggested by the cited references and is patentable thereover for the following reasons.

Claim 1 vs. Le Coz

Difference in Ball Size

Le Coz teaches balls "having a diameter as small as 0.03 inch (about 760 μm) and perhaps even smaller". (Col. 1, lines 64-65). Le Coz uses balls having a diameter of slightly greater than about 0.03 inch (about 760 μm) (column 4, line 67 to column 5, line 3).

In contrast, the present invention uses balls having a diameter of 60 to 150 μm , which is much smaller than that of Le Coz. Balls of such a small size are very difficult to handle in comparison with the larger balls of Le Coz.

The "760 μm " diameter ball size of Le Coz has a diameter (or radius) about 5 times greater than the maximum "150 μm " diameter ball size of the present invention.

Of great significance, the "760 μm " diameter ball size of Le Coz has a volume or weight (for a given metal) which is 130 times greater than the volume or weight (for a given metal) of the maximum "150 μm " diameter ball size of the present invention.

The volume or weight (for a given material) of a sphere is a function of the radius cubed. The volume of a sphere is given by the formula $V = \frac{4}{3}\pi R^3$.

The volume and the weight of the small balls of the present invention are very significantly smaller than the volume and weight of the large balls disclosed or suggested by Le Coz. The small balls of the present invention are very much more difficult to handle than the large balls of Le Coz.

Le Coz is directed to a different technology than the present invention. The ball sizes of Le Coz are very significantly different than the small balls of the present invention in terms of volume and weight. Le Coz suggests nothing to one skilled in the art with respect to use of small balls for plating a substrate of electronic devices. Le Coz discloses the use of large balls referred to in Le Coz as spacers. See, e.g., Col. 1, lines 56-65 of Le Coz.

The present inventors were first to discover a method using small balls for plating a substrate of an electronic device using metal balls having a diameter of 60 μm to 150 μm .

No prior art has been cited which uses metal balls having a diameter of 60 μm to 150 μm for plating a substrate of an electronic device.

Difference in Melted Form

Le Coz uses balls as a spacer element (Col. 1, lines 56-59) to provide a distance from a substrate or other bonding objects. See Fig. 6 of Le Coz. To this end, reflowing of the balls of Le Coz must be performed only to an extent such that even after the melting, the balls are still somewhat in the form of a sphere as shown in Fig 6 of Le Coz.

With reference to Col. 6, lines 62-65 of Le Coz, Fig. 6 of Le Coz illustrates "the resulting circuitized substrate". Fig. 6 of Le Coz illustrates the spacers or balls 15 of Le Coz after reflowing.

In contrast, the present invention relates to a surface finishing technology for coating electrodes or other plating objects by melting small metal balls to form a plated layer thereon, which is clearly distinguished from the spacer member or ball 15 of Le Coz.

Therefore, claim 1 is patentable over Le Coz.

Claim 2

In the present invention, small balls 60 to 150 μm in diameter are extremely light in weight and are very likely to adhere to the surface of the arrangement base plate with a minute amount of grime or water absorbed thereon. Therefore, while arranging small balls of the present invention, the balls are very likely to adhere to the surface of an arrangement base plate and leave the adhered balls as excess balls.

According to the present invention, as shown in Figs. 2(a) and 2(b) of the present application, arranging metal balls includes lowering an arrangement base plate 13 to above a ball container 10 and picking up balls from the ball container 10 by vacuum suction at through holes 11, with the surface of the arrangement base plate facing downward, thereby reducing probability of excess balls adhering to the surface of the arrangement base plate 13.

Having the ball adhering surface of the arrangement base plate facing downward during the provisional arranging

and holding procedure of the present invention, facilitates the dropping of excess balls from the ball adhering surface by their own weight. (Adhered excess balls are removed by applying vibration. See claims 3 and 4).

With reference to Figs. 1, 2, 3 and 4 of Le Coz, the arrangement base plate (carrier 11) of Le Coz has its ball adhering surface facing upward during the provisional arranging and holding procedure.

Amended dependent claim 2 is not disclosed or suggested by Le Coz and is separately patentable.

Claims 3 and 4

With reference to Figs. 1 and 2 of Le Coz, Le Coz provides a template 31 over the arrangement base plate (carrier 11) during the initial arrangement of balls. With reference to Fig. 3 of Le Coz, Le Coz then removes the template 31 from the arrangement base plate or carrier 11. The template 31 of Le Coz prevents excess balls from adhering to the ball adhering surface of the arrangement base plate or carrier 11 of Le Coz. The technology of Le Coz is entirely different than the present invention.

Concerning the removal of excess balls by vibration, the Office Action states at page 4, lines 14 to 18, that Le Coz teaches a provisionally arranging and holding procedure, wherein excess metal balls 15 are adhered to the arrangement base plate 11, 21, 31 and removed by applying vibration from the suction of the arrangement base plate.

However, this observation of the Office Action is not correct. Le Coz, column 5, lines 32 to 36, actually reads:

"Accordingly, this vacuum assures positive retention of the larger solder ball elements 15 with the smaller holes 13 to thus prevent removal of these solder ball elements as may occur (e.g., caused by vibrations) during normal additional manufacturing operations."

This statement of Le Coz only means that removal of the balls may undesirably occur due to vibration during the normal manufacturing process. Le Coz is quite silent about intentional removal of excess balls by vibration or the advantageous effect thereof.

The Office Action at page 6, lines 9-15, states that Le Coz discloses vacuum through apertures 33, which imparts ultrasonic vibration to the template or suction head.

However, this position taken by the Office Action is only speculation. Le Coz actually discloses or suggests nothing about vibration caused by vacuum.

Le Coz is different from the present inventive intentional application of vibration to remove excess balls. The present inventors first found that ultrasonic vibration most effectively removes excess balls, which is clearly different from Le Coz's non-intentional vibration undesirably occurring during normal manufacturing process.

Therefore, dependent claims 3 and 4 are separately patentable over Le Coz.

Claims 4, 6 and 9

Dunaway

Dunaway relates to forming a bump by vacuum deposition and is essentially different from the present invention.

The bump formation by vacuum deposition uses vacuum equipment costing too much for commercial application and also involves large material loss causing environmental problems to occur. Moreover, vacuum deposition requires control of vapor pressure of the source material to provide a product with desired chemical composition, which makes it difficult to form a metal alloy with a desired composition.

In contrast, the present invention does not require any specially designed equipments and instead uses a selected ball size for a desired amount of plated layer in which material loss is minimized and the production cost is reduced in comparison with the vacuum deposition process. The present invention also has the advantage that a plated layer with a desired chemical composition, including metal alloys, can be easily obtained merely by using metal balls of a desired material, increasing freedom of material selection.

The Office Action states at page 6, lines 18 to 20, that Dunaway teaches balls 80 made of gold and a lead frame plated with gold.

However, Dunaway discloses nothing about gold balls and it is submitted that Dunaway forms gold bumps by wet process plating. It is also submitted that the lead frames of Dunaway are plated with gold through wet process. The wet process causes an environmental problem due to the waste solutions, requires complicated equipment, and is poor in material selection.

The present invention provides a novel partial plating process, which is not a wet process, and only

requires relatively simple equipment causing no environmental problems with improved freedom of material selection.

By the present amendment, claim 1 has been amended by adding the limitation --with no plating solutions used--.

Thus, the present invention is clearly distinguished from Dunaway.

It is submitted that dependent claim 4, 6 and 9 are separately patentable over the combination of Le Coz and Dunaway.

Summary

To summarize, the present invention defined by amended independent claim 1 is not disclosed or suggested by Le Coz and/or Dunaway. Therefore amended independent claim 1 is patentable over Le Coz and/or Dunaway.

Dependent claims 2 to 4 and 6 to 11, dependent from claim 1 directly or indirectly, include all of the features of claim 1 and are therefore patentable for the same reason as discussed above for claim 1.

The dependent claims are also separately patentable over the Le Coz and/or Dunaway for the reasons discussed above.

CONCLUSION

It is submitted that in view of the present amendment and foregoing remarks, the application is now in condition for allowance. It is therefore respectfully requested that the application be allowed and passed to issue.

Respectfully submitted,

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